

CEDAR HILLS REGIONAL LANDFILL 2016 ANNUAL REPORT



King County

Department of
Natural Resources and Parks
Solid Waste Division

Waste
Prevention

Resource
Recovery

Waste
Disposal

www.kingcounty.gov/solidwaste

March 2017

2016 ANNUAL REPORT CEDAR HILLS REGIONAL LANDFILL

MARCH 2017

Thanks to following KC Solid Waste Division staff members for their contributions:

Eben Sutton
Eric Johnson
Jennifer Keune
Kris McArthur
Laura Belt
Manny Cristobal
Michael Bezanson
Mizanur Rahman

Shirley Jurgensen
Stephanie Mano
Sterling Bath
Terri Barker
Theresa Atkinson
Toraj Ghofrani
Tom Theno

Prepared by:
Facility Engineering and Science Unit
King County Solid Waste Division

Date Prepared:
March 31, 2017

2016 ANNUAL REPORT CEDAR HILLS REGIONAL LANDFILL

CONTENTS

1.	Overview	1
2.	Facility Information	1
3.	Landfill Capacity and Development Status	2
4.	Financial Assurance Analysis	4
5.	Waste Disposal Quantities	5
6.	Summary of Groundwater, Stormwater, Leachate, and Landfill Gas Monitoring Results and 2017 Proposed Environmental Monitoring Program	5
6.1	Summary of the Groundwater Monitoring Program	5
6.2	Summary of the Stormwater Monitoring Program	6
6.3	Summary of the Leachate Monitoring Program	6
6.4	Summary of the Landfill Gas Monitoring Program	7
6.5	Environmental Monitoring Program for 2017	7
7.	Summary of Landfill Personnel Training Program	8
8	Evaluation Reports	9
8.1	Summary of Emergency or Corrective Actions Taken in 2016	9
8.2	Evaluation of Stormwater Monitoring Data	10
8.3	Groundwater Monitoring Data	11
8.4	Evaluation of Gas Monitoring Data	13
8.5	Evaluation of Wastewater Monitoring Data and Volume Generated	14
8.6	Landfill Settlement	15
9.	Attachments	16
	Attachment A – Permit Renewal Application	
	Attachment B – Tonnage Report	
	Attachment C – Disposal Fees	
	Attachment D – Landfill Capacity Documentation	
	Attachment E – Financial Assurance Documentation	
	Attachment F – Annual Summary of Groundwater Monitoring Results	
	Attachment G – Landfill Gas Monitoring Results	
	Attachment H – Stormwater Reports	

SECTION 1 - OVERVIEW

The King County Solid Waste Division (KCSWD) owns and operates the Cedar Hills Regional Landfill (CHRLF) in eastern King County for the disposal of municipal solid waste generated in the County, exclusive of the cities of Seattle and Milton. It is a 920-acre site located at 16645 228th Avenue Southeast, off Cedar Grove Road, three miles north of Maple Valley, six miles east of the City of Renton and about four miles south of the City of Issaquah. In addition to the landfill, the site contains Passage Point, a transitional housing facility; a landfill gas-to energy facility owned and operated by Bio Energy Washington, LLC (BEW); a right-of-way for a natural gas pipeline and numerous power transmission line rights-of-way.

Filling operations are continuing in Area 7. Area 7 is anticipated to have capacity through early 2019. Design of Area 8 is in the final phase of design and is out for bids. Construction will begin in 2017 and is anticipated to be completed in 2018. Area 7 staged closure projects to occur in 2017 and 2018 are also out to bid.

This report includes a compilation of activity summaries and system evaluations associated with the following:

- Landfill capacity;
- Financial assurance cost estimates for closure and post-closure;
- Changes to landfill operations; and,
- Environmental monitoring program, including a summary of groundwater, stormwater, leachate, and landfill gas monitoring results and exceedances.

This annual report is submitted pursuant to the provisions of the Washington State Criteria for Municipal Solid Waste Landfills, Operating Criteria - Annual Reports (WAC 173-351-200(11)) and the Cedar Hills Regional Landfill Operating Permit, Section XII - Reporting Requirements, Part B - Annual Report and Permit Renewal Application. The Washington Department of Ecology (WDOE) form required for submittal of this report is included in this section.

In 2017, there was no Permit Renewal Application; Attachment A therefore is being held in reserve for future use.

SECTION 2 - FACILITY INFORMATION

Required Facility information on forms provided by Ecology is contained in Attachment B.

Significant Facility Activities which occurred in 2016 were: the relocation of stormwater and contaminated stormwater facilities from the future Area 8 footprint to a location to the south; construction

of a new landfill gas delivery pipeline along a new alignment from the North Flare Station to the Bio Energy Washington Facility; and design activities for Area 8 and Area 7 staged closure projects.

In 2017, the construction of Area 8 will begin. Construction is anticipated to be complete in 2018. Stage 3 Final and Interim Cover over exterior slopes of Area 7 will be placed in 2017 and Stage 4 Final and Interim Cover will be placed in 2018. KCSWD will continue to review Site Development Plan Alternatives for extending the life of CHRLF in 2017.

SECTION 3 - LANDFILL CAPACITY AND DEVELOPMENT STATUS

Cedar Hills has built capacity remaining in three areas (Area 5 – 1,923,000 cubic yards, Area 6 – 1,367,000 cubic yards, and Area 7 – 3,244,000 cubic yards) totaling 6,534,000 cubic yards. These capacities are based upon the difference between existing landfill contours (September 14, 2016 aerial survey and a design surface at completion. Attachment D contains the existing landfill contours and design surfaces at completion, and additional documentation for calculating capacity.

Efforts are underway to optimize the use of this remaining built capacity. These include decreasing the amount of airspace consumed by disposal and recovering airspace gained due to settlement.

The amount of airspace available for disposal is impacted by airspace consumed by daily cover and road construction. The use of tarps for alternative daily cover, and the recovery of rock used for roads increases the airspace available for disposal. Additionally, mechanical compaction increases the airspace available for disposal.

As the landfill ages, it settles. Airspace from settlement can be recovered for disposal. Settlement occurs due to consolidation and to loss of mass from leachate and more importantly gas production. As gas is collected, it is removed from the landfill. The airspace gas once occupied consolidates and the landfill settles. Soil surcharge can be used to accelerate settlement. Areas 5 and 6 both have areas of soil stockpiled over them to accelerate settlement. This soil will be recovered later for other uses.

CHRLF has a planned capacity addition of 7,842,000 cubic yards for Area 8. Area 8 is currently in the process of permitting and bidding. Construction is planned to occur in 2017 and 2018.

In addition to Area 8, a topping lift over Areas 7 and 8 with a capacity of 1,081,000 cubic yards is planned to bring Areas 7 and 8 to a permitted maximum design surface of 800 feet. Attachment D contains the contours used to calculate Area 8 capacity and the capacity of the top lift.

The table below presents current and planned capacity in cubic yards and tons by area, as of September 14, 2016. It is based upon an airspace utilization of 1,600 pounds of refuse disposed per cubic yard of air space consumed, and an average yearly tonnage of 1,025,000 tons (forecasted between 2017 and 2028). 1,600 pounds per cubic yard is the airspace utilization achieved in Area 7 using current operational practices (compaction, daily cover usage, and rock recovery). See Attachment D for details.

Area	Capacity (cubic yards)	Capacity (tons)	Capacity (years)
5	1,923,000	1,538,400	1.5
6	1,367,000	1,093,600	1.1
7	3,244,000	2,595,200	2.5
8	7,842,000	6,273,600	6.1
7 & 8 Top Lift	1,081,000	864,800	0.8
Total	15,457,000	12,365,600	12

The development status of the landfill is summarized in the table below. Closed Areas are Refuse Areas closed in accordance with pertinent regulatory requirements and not currently scheduled to receive additional waste. The Area 5 and Area 6 top surfaces have interim covers that will be maintained until the completion of the last remaining lifts.

STATUS OF LANDFILL AREAS¹

Landfill Area	Closed Area Size (acres)	Open Area Size (acres)
Main Hill	84.4	0.0
Southeast Pit	9.6	0.0
South Solid Waste Area	30.6	0.0
Central Pit	5.5	0.0
Area 2/3	22.2	0.0
Area 4	60.4	0.0
Area 5	9.2 ² 37.1 ³	31.4
Area 6	25.18 ² 37.4 ³	30.1
Area 7	2.9 ² 9.2 ³	50.1
Area 8	Not Developed	Not Developed
1. Areas are net final cover plan view surfaces or as otherwise noted. 2. Final cover surface area. 3. Interim final cover surface area.		

SECTION 4 - FINANCIAL ASSURANCE ANALYSIS

The KCSWD maintains a Landfill Reserve Fund (LRF) account for new area development, closure, post-closure, and corrective action in accordance with WAC 173-351-600. The LRF receives monthly transfers from the KCSWD operating fund, which obtains about 94% of its revenue each year from customers paying the waste disposal fee for MSW brought into the KCSWD solid waste system. The transfer amount is set during the disposal rate approval process and adjusted annually. New Rates were adopted in 2016. The 2016 LRF contribution was \$16.76 per ton and the 2017 contribution is \$18.00. In addition to the requirements of Washington Administrative Code 173-351-600 requiring the LRF to provide financial assurance for closure and post-closure care, King County Code (4A.200.390) requires the LRF to include funding for new area development costs.

The current LRF rate is based on projected expenditures forecasted when the current rate was adopted in 2016. The details which the LFR contribution were based upon in the rate are included in Attachment E.

In 2017 we will assess the following items and calculate a new LFR contribution for 2018.

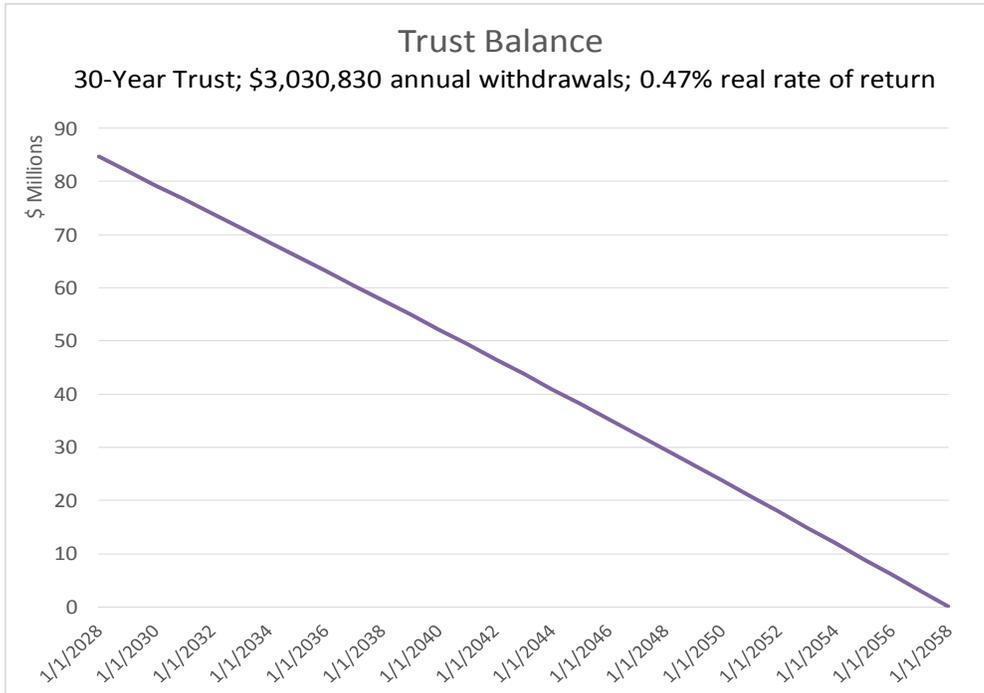
- [a] Updated tonnage forecast;
- [b] The current interest rate set by the King County Office of Economic and Financial Analysis OEFA;
- [c] Updated projected costs in each future year, for Closure, New Area Development, and Facility Improvements;
- [d] Updated assumption that waste receipt will stop in October of 2028, and final closure completed in 2030;
- [e] Updated Post Closure Maintenance Estimate.

The post-closure maintenance estimate has been updated. The updated estimate is based on current costs for maintenance of the systems, and considered whether there have been changes to the environmental control systems that would lead to changes in maintenance costs and any changes to current costs of maintenance.

Based on recommendation of King County Auditor's Office, the KCSWD uses the King County Office of Economic and Financial Analysis (OEFA) forecast for the both inflationary assumptions, and likely future investment return interest rates. The current direction is to use a real (after inflation rate of return of 0.47%.

This year's estimate is that \$3,030,830 (2016 dollars) per year will be required to maintain the landfill for 30 years for a total of \$90.9 million in expenses over the closure period. The back ground for this year's estimate is included in Attachment E. The \$90.9 Million in total spending can be sustained over a 30-year period with a trust fund of about \$84.6 million invested in government-backed securities paying a real (after inflation) rate of return of 0.47%.

This updated estimate will be used in calculating the LFR fund contribution for 2018.



SECTION 5 - WASTE DISPOSAL QUANTITIES

The CHRLF received an average of 2,519 tons of municipal solid waste a day in 2016. Detailed information can be found in Attachment B.

SECTION 6 - SUMMARY OF 2016 GROUNDWATER, STORMWATER, LEACHATE AND LANDFILL GAS MONITORING PROGRAM AND 2017 PROPOSED ENVIRONMENTAL MONITORING PROGRAM

6.1 Summary of Groundwater Monitoring Program

Groundwater monitoring is conducted in accordance with WAC 173-351-410 and reported here in compliance with WAC 173-351-415(1). A summary of groundwater data collected during the reporting year is presented in Part 7 of Attachment F.

The Groundwater Monitoring Program is described in the *Environmental Monitoring Sampling and Analysis Plan for Cedar Hills Regional Landfill* and in Attachment F of this annual report. Thirty six (36) groundwater monitoring wells are used for monitoring groundwater elevations and geochemical sampling in the regional aquifer, and nine (9) for monitoring the perched saturated zones. Five (5) additional wells in the regional aquifer and thirteen (13) additional wells in the perched zones are monitored only for groundwater elevations. Detection monitoring wells are located down-gradient of, or lateral to, waste placement areas. Background characterization wells are located up-gradient of waste placement areas.

6.2 Summary of Stormwater Monitoring Program

The stormwater monitoring program is described in the *Environmental Monitoring Sampling and Analysis Plan for Cedar Hills Regional Landfill* (2013). The goals of this program include the following elements:

- Monitor the effectiveness of Best Management Practices (BMPs) per the Stormwater Pollution Prevention Plan (SWPPP); and
- Evaluate compliance with the Industrial Stormwater General Permit (ISGP).

Stormwater discharges associated with industrial activities at CHRLF are covered by the ISGP, which establishes monitoring requirements and benchmark values for several parameters. Three (3) discharge locations are monitored quarterly for compliance with the ISGP. Permit compliance monitoring locations are at N4 at the north end of the landfill, GS1 at the south end and SL3 at the discharge of the bioswale along 228th Avenue Southeast.

In addition to routine monitoring conducted in accordance with the ISGP, KCSWD maintains several contingency surface water monitoring stations. The purpose of the contingency monitoring stations is to allow additional surface water monitoring if ISGP monitoring results exceed applicable benchmarks and broader surface water monitoring is warranted.

Field and analytical stormwater data are included in Part 7 of Attachment F.

6.3 Summary of Leachate Monitoring Program

KCSWD collects two types of leachate samples at CHRLF: characterization and compliance. Leachate characterization is a critical component of detection monitoring, enabling the detection of any potential for groundwater contamination by leachate. Leachate characterization also serves to assess pretreatment needs prior to discharge and to evaluate the effectiveness of pretreatment. Characterization includes all analytes that groundwater is analyzed for plus several analytes specifically related to wastewater characterization and treatment. Monthly characterization samples are collected at four monitoring locations: LEPS, LAPI, PS-2A, and MH-46N.

Compliance samples refer to those collected in support of compliance with Wastewater Discharge Permit No. 7842-02. Monthly compliance samples collected from LEPS are analyzed for all permit-specified parameters. Sample concentrations are used in conjunction with flow data to calculate

loadings. Compliance is determined by comparing results to allowable limits specified in permit no. 7842-02.

Self-monitoring discharge permit reports are generated monthly and submitted to the King County Wastewater Treatment Division, Industrial Waste Program.

Field and analytical leachate data are included in Part 7 of Attachment F.

6.4 Summary of Landfill Gas Monitoring Program

Landfill gas (LFG) monitoring is performed in accordance with provisions of WAC 173-351-200(4). A network of LFG monitoring probes has been installed at strategic locations and elevation intervals below the ground surface to measure LFG composition and pressure (see Attachment E). In general, there are two categories (defined by function) of probes at the CHRLF. Migration Monitoring Probes are primarily intended to verify that methane concentrations at the property boundary are not exceeding the lower explosive limit (LEL) for methane (typically 5 percent, by volume) and whether subsurface LFG is migrating into surrounding native soils. Interior LFG Monitoring Probes are used to evaluate and manage the performance of the LFG collection system and will indicate if any operational adjustments to the system are required.

Monitoring Probe Network: The installation history of the LFG monitoring probes at the CHRLF was described in the 2005 CHRLF Annual Report. The probes are either single or multiple completion probes. Information on the location, elevation, and installation date, and a description of each probe is provided in the Monitoring Plan figure included in Attachment G. Parameters typically measured at the LFG monitoring probes include methane, oxygen and carbon dioxide concentrations and static pressure. Monitoring is performed quarterly for compliance with WAC 173-351, and monthly for operational indicators. Monitoring data results are included in Attachment G. Results from LFG migration monitoring for 2016 are discussed in Sections 8.1 and 8.3 of this report.

Cedar Hills Buildings as well as Passage Point Buildings are also monitored for methane. There were no detections in 2016 of methane above 7 parts per million (ppm). The regulatory limit is 100 ppm.

6.5 Environmental Monitoring Program for 2017

Effective January 1, 2016, KCSWD began implementing the *Environmental Monitoring Sampling and Analysis Plan for Cedar Hills Regional Landfill* (SAP) (December 31, 2013), as approved by PHSKC and WSDOE in 2015. The SAP outlines current monitoring programs designed to comply with the requirements of Chapter 173-351 WAC as well as other applicable environmental regulations and permits, including wastewater discharge permits and stormwater permits.

If and when changes to the SAP are deemed appropriate, KCSWD will seek approval of such changes from PHSKC and WSDOE.

SECTION 7 - SUMMARY OF LANDFILL PERSONNEL TRAINING PROGRAM

The KCSWD implements a Landfill Training Program that ensures that landfill personnel comply with the Certification requirements of WAC 173-300-060. Employees with earned SWANA Landfill Certification as Manager of Landfill Operations (MOLO) are listed below in the table below.

MOLO Certifications

NAME	TITLE	DATE OF CERTIFICATION
John Hills	Lead Equipment Operator	Certified through April 2018
Lenny Kuzaro	Equipment Operator	Certified through April 2018
Rusty Bogart	Landfill Gas Operator	Certified through October 2018
Nigel White	Special Projects Manager	Certified through October, 2019
Wally Grant	Landfill Gas Supervisor	Certified through May, 2019
Shawn Carter	Transportation Supervisor	Certified through October 2017
Scott Barden	Landfill Operations Manager	Certified through October 2017
Bill Berni	Operations Manager	Certified through July 2018
Kris Burgin	Operations Supervisor	Certified through May 2019
Jason Gonzales	Lead Equipment Operator	Certified through May 2019
Lynn Walters	Operations Supervisor	Certified through May 2019
Mark Hammer	Assistant Operations Manager	Certified through May 2019
Anthony Slaughter	Operations Supervisor	Certified through May 2019

SECTION 8 - EVALUATION REPORTS

8.1 Summary of Emergency or Corrective Actions Taken in 2016

8.1.1 Stormwater Corrective Action

When stormwater monitoring indicates exceedances of benchmark limits established in the ISGP, the permittee must take corrective actions to remain in compliance with the permit. Sampling results in 2016 indicated select benchmark limits were exceeded, thus, KCSWD undertook the following corrective actions.

<i>Trigger</i>	<i>Corrective Action</i>
Repeat benchmark exceedances in 2014	Constructed a new stormwater treatment and flow control facility in 2016
Vehicle rollover accident released diesel to stormwater ditch and onsite wetland in January 2016	Improved road in vicinity of accident, including paving shoulders and correcting super-elevation
Turbid stormwater discharges associated with the Area 8 construction project.	Worked with contractors responsible for temporary erosion and sediment control to improve water quality of construction discharges

Additional details regarding exceedances and corrective actions are contained in the Discharge Monitoring Reports and Annual Report included in Attachment H.

8.1.2 Wastewater Discharge Permit Corrective Action

No emergency or corrective actions were taken with respect to the Wastewater Discharge Permit issued to the CHRLF in 2016.

8.1.3 Inspection Reports and Corrective Actions

In 2016, PHSKC inspected CHRLF nine times, seven of which were deemed satisfactory, one was deemed complete, and one was deemed unsatisfactory. Corrective actions taken in response to inspection reports included routine maintenance activities such as litter collection and vegetation management.

KCSWD identified and repaired a small leachate seep that occurred in the vicinity of the wheel wash on the haul road between Areas 5 and 7 in March 2016. PHSKC was notified of the seep and its repair.

8.1.4 Title V Air Operating Permit Deviation Reports

KCSWD reports deviations from the Title V Air Operating Permit by submitting Deviation Reports to the Puget Sound Clean Air Agency (PSCAA) if they occur. The Title V Air Operating Permit establishes a standard for air intrusion for the landfill gas collection system. The standard for air intrusion is that oxygen concentration should be less than 5 percent. There was a deviation from oxygen standards in 2016 between April 6th and April 26th at A5A6SC1E.

8.1.5 Independent Remedial Action

KCSWD is proceeding with and Independent Remedial Action with respect to the East Perched Zone under the Model Toxics Control Act (MTCA) in accordance with WAC 173-340-510 and 173-340-515. KCSWD issued a Remedial Investigation/Feasibility Study (RI/FS) in December of 2016. Data collected during this effort is not presented or discussed in this annual report.

8.1.6 Leachate Aeration Basin Anomaly Investigation

In the summer of 2016, the leachate aeration basins were partially drawn down to try to expose and investigate certain anomalies that had been detected in a 2015 electro-resistivity survey. A problem with a valve was encountered which prohibited complete draw down. An anomaly in the east pond was exposed and a patch installed over the area (note; no visible holes or tears, a small dimple in the geomembrane was observed). Bottom anomalies and a side-slope anomaly in the west pond could not be investigated until the defective valve was repaired. Because of the on-coming rainy season further investigation was deferred until 2017. This work including valve repair is included in bid documents for Area 8.

8.2 Evaluation of Stormwater Monitoring Data

The CHRLF operates under a National Pollutant Discharge Elimination System (NPDES) ISGP, number WAR000756. Three (3) discharge points are monitored in compliance with the ISGP. These points are N4 to the north, GS1 in the south, and SL3 along 228th Avenue SE.

Under the ISGP, quarterly sampling is required for the following twelve (12) parameters: BOD, total suspended solids, ammonia (total as N), alpha terpineol, benzoic acid, p-Cresol (4-methylphenol), phenol, zinc (total), pH, turbidity, copper (total), and oil sheen. Field and analytical stormwater data are included in Part 7 of Attachment F.

Monitoring station N4 monitors discharges to an unnamed tributary to McDonald Creek, which ultimately flows into Issaquah Creek. Monitoring station SL3 monitors discharges to a series of roadside ditches along 228th Avenue SE and Cedar Grove Road. While the ditches ultimately connect to the Cedar River, the underlying geology is highly infiltrative, resulting in the infiltration of stormwater discharging from CHRLF long before it reaches the Cedar River. Monitoring station GS1 monitors discharges to a designated King County wetland with palustrine forested, palustrine open water, and palustrine emergent wetland classes. The wetland does not contain key aquatic life uses.

Exceedances of the ISGP for 2016 are summarized in the table below.

**SUMMARY OF 2016 STORMWATER MONITORING DATA
THAT EXCEEDED ISGP CRITERIA**

Sample Period	Sample Result	Unit	Criteria		
			Benchmark	Effluent Limit	
			Quarterly Average	Monthly Average	Daily Maximum
Sample Location: N4					
Q1	No exceedances				
Q2	No exceedances				
Q3	No exceedances				
Q4	Zn = 111	ug/L	117	110	200
Sample Location: GS1					
Q1	Oil sheen = Y	Y/N	Y	--	--
Q2	Oil sheen = Y	Y/N	Y	--	--
Q3	No exceedances				
Q4	Turb = 273	NTU	25	--	--
Q4	Cu = 22.2	ug/L	14	--	--
Q4	TSS = 117	mg/L	--	27	88
Sample Location: SL3					
Q1	No exceedances				
Q2	No exceedances				
Q3	No exceedances				
Q4	No exceedances				

	= criteria exceeded	ug/L	= micrograms per liter
	TSS	= total suspended solids	mg/L
	Turb	= turbidity	= milligrams per liter
	Cu	= copper	NTU
	Zn	= zinc	= Nephelometric turbidity unit
			--
			= not defined

8.3 Groundwater Monitoring Data

Groundwater at the CHRLF occurs both in a regional aquifer and in perched zones. The regional aquifer flows through advance outwash and deeper deposits and is separated from the base of waste placement areas by more than 200 feet of unsaturated sands and gravels. Perched groundwater occurs in onsite till, ice-contact deposits and recessional outwash. No laterally or vertically extensive perched zones have been identified, leaving the regional aquifer beneath the landfill as the earliest target hydraulic pathway for groundwater contaminant detection.

Attachment F contains a detailed analysis of groundwater monitoring results. Sections 8.3.1 and 8.3.2 give a summary of the conclusions of the Annual Groundwater Monitoring Report certified in Attachment F.

8.3.1 Regional Aquifer

The regional aquifer beneath CHRLF is entirely recharged by precipitation. A local recharge area is located immediately south of the landfill within the Queen City Farms (QCF) property, and is centered north of the Main Gravel Pit Lake. In general, groundwater flow in the regional aquifer is radial from the recharge area. Beneath the landfill, regional flow is to the north in the south and central portions of the landfill site. Flow direction in the northern part of the site turns northeasterly as recharge from the McDonald Creek drainage affects flow patterns. Regional aquifer flow is physically separated from the Cedar River and likely discharges to Issaquah Creek. There is no significant seasonal variation in horizontal groundwater flow paths. Horizontal gradients are influenced by infiltrating precipitation in the recharge area. Vertical hydraulic gradients are demonstrated by head differences in adjacent wells screened at different depths and related to hydraulic conductivity of the aquifer materials. A flow path analysis has been completed for the site and indicates a complex flow regime in the landfill vicinity

A monitoring network is in place consisting of forty (40) monitoring wells located to characterize groundwater flow and to obtain representative samples for water quality characterization. Downgradient flow converges into a high transmissivity zone which provides excellent monitoring coverage for all flow paths within the potential source area.

An extensive list of chemical analytes and field parameters are analyzed and the results are evaluated by a variety of graphical and statistical methods. The groundwater data analyses presented in this report describe onsite groundwater elevations, flow direction and velocity, and summarizes the evaluation of groundwater quality to determine if chemical concentrations have changed over time or differ between well locations. This report determines if these findings are indicative of impacts to groundwater quality by surface activities.

Upgradient groundwater quality, especially in wells nearest the southern recharge zone, is profoundly affected by conditions and activities that have occurred on the adjoining QCF property. Upgradient groundwater quality manifests a high degree of spatial variation and increasing trends, which are expected given recharge area site history which has included a variety of land uses, investigations and remediation and ongoing land surface modifications.

As flow continues into areas beneath the landfill footprint changes are discernible as groundwater encounters and equilibrates to different oxidation-reduction conditions, soil gas/groundwater interface conditions and solvent/solute interactions. Flow paths under the landfill footprint and immediately downgradient of waste cells are influenced by the presence of LFG in the unsaturated strata. Flow paths in the north landfill area (aligned along MW-66, MW-74, MW-75 and MW-85) are

notably higher in chloride concentrations. The data are consistent with an input from onsite, overlying infrastructure in the north end. Concentrations have declined since maximum levels were reached in 2008-2010 in MW-74. Dispersion along the flow-path is apparent in other wells.

Downgradient groundwater quality also manifests a high degree of spatial variation and temporal trends. Much as recharge effects are dampened with distance from the source, the concentrations of many analytes are attenuated by processes such as dispersion dilution, sorption, and degradation as groundwater flows beneath the landfill. The highest concentrations of certain analytes occur in upgradient wells. Groundwater quality in the regional aquifer leaving the site remains consistent with historical data.

The data indicate that CHRLF acts as an attenuation zone for upgradient impacts, allowing a reduction in the concentration of chlorinated volatile organic compounds (CVOCs).

Site hydrogeological reports and supporting documentation identify the regional aquifer is the first continuously saturated zone beneath the landfill and serves as the earliest path for detection monitoring. Recent water quality evaluations of QCF groundwater are available in the *2010 Expanded Hydrogeology Assessment Queen City Farms King County, Washington*, (2010), *2011 Final Data Report Queen City Farms Maple Valley, Washington* (2012) and *Fourth Five-Year Review Report for Queen City Farms* (2013).

8.3.2 Perched Zones

Perched groundwater occurs in onsite till, ice-contact deposits and recessional outwash. No laterally or vertically extensive perched zones have been identified. Recharge is by precipitation with possible hydraulic continuity to surface streams.

Impacts from past landfilling practices have previously been recognized in several perched zones. Site improvements and engineered facilities have been effective in reducing contaminant concentrations attributable to past practices. Declining or stable long term trends for many contaminants are apparent in these wells.

The East Main Hill perched zone is undergoing an independent clean up action led by KCSWD. Recent investigation findings for this zone are presented in the *East Perched Zones Remedial Investigation and Feasibility Study*, December 2016. A discussion of conditions in the perched zone near the former South Solid Waste Area are available in the Technical Memoranda *Results of Groundwater Sampling and Fate and Transport Analysis South Solid Waste Area Perched Zone Assessment*, April 2010.

8.4 Evaluation of Gas Monitoring Data

See Attachment G for LFG probe monitoring data. According to WAC 173-351-200 (4) (a), the concentration of methane gas generated by the facility shall not exceed 25 percent of the lower explosive limit (LEL) for methane in facility structures (excluding gas control or recovery system components), exceed the LEL for methane at the facility property boundary or beyond, or exceed 100 ppm by volume of methane in off-site structures.

The LFG compliance monitoring probes (LFG migration monitoring probes) are located along the perimeter of the landfill as shown in Attachment G. The rest of the probes are used to monitor LFG levels in the interior of the landfill and for transitional evaluation of LFG collection and extraction-specific facilities.

KCSWD has historically monitored landfill gas on a monthly or quarterly basis for compliance with WAC 173-351. In addition to this compliance monitoring, additional monitoring has occurred at the perimeter and interior probes to provide information to the LFG extraction system operators. All the monitoring data for the year for the perimeter compliance probes is included in Attachment G.

Cedar Hills Buildings as well as Passage Point Buildings are also monitored for methane. There were no detections in 2016 of methane above 7 ppm. The regulatory limit is 100 ppm.

8.5 Evaluation of Wastewater Monitoring Data and Volumes Generated

Leachate collected throughout the landfill is routed to the Leachate Effluent Pump Station (LEPS) where it mixes with other, smaller sources of wastewater at CHRLF (e.g., contaminated stormwater, gray water, and BEW process water). Following aeration, the combined wastewater discharges to the King County sewerage system pursuant to a Waste Discharge Permit issued to KCSWD by the King County Industrial Waste Program (KCIW) (permit no. 7842-02).

8.5.1 Wastewater Volumes

The recorded volumes of wastewater discharged from the leachate aeration basins by way of the LEPS are indicated in the table below. The actual leachate volume generated within the landfill is not measured directly.

LEACHATE DISCHARGE DATA AND EXCEEDANCES FOR 2016

Month	Flow (million gallons)	Daily Max Discharge Volume Exceedances (limit = 2.7 million gallons per day)
January	24.9260	None
February	24.7314	None
March	25.7217	None
April	7.3150	None
May	6.4106	None
June	4.4378	None
July	4.4630	None
August	8.0376	None
September	1.5052	None

October	22.9855	1
November	29.4720	None
December	21.1029	None
Total	181.1087	1
Average/Month	15.0924	0

8.5.2 Wastewater Monitoring Data

A compilation of leachate monitoring data is included in Part 7 of Attachment F. All wastewater discharges from the LEPS in 2016 were in compliance with permit-specified effluent limits (volume, concentration, and loading) with the three exceptions described below.

- On June 19, 2016, the instantaneous maximum concentration of atmospheric hydrogen sulfide was measured at 10.5 parts per million at monitoring location R10-52, slightly above the permit limit of 10.0 parts per million. Monitoring data indicate that the exceedance lasted less than 15 seconds and subsequent data showed a virtually immediate return to compliance. Monitoring location R10-52 is not located on the landfill property; rather, it is located several miles down gradient of the landfill at the point where the sanitary sewer pipe constructed for Cedar Hills Regional Landfill connects with King County Metro's sewer main.
- On October 17, 2016, wastewater discharged from the Cedar Hills Regional Landfill contained a total of 1.7 pounds of chromium, an exceedance of the 1.2 pound limit specified in permit no. 7842-02. Subsequent samples collected on October 31, 2016 and November 8, 2016 both indicated chromium loading was back within acceptable limits.
- On October 31, 2016, the total volume of wastewater discharged from the Cedar Hills Regional Landfill was 2.8446 million gallons, slightly higher than the permit limit of 2.7 million gallons per day. The elevated discharge volume was attributed to heavy precipitation in the latter half of the month. Compliance with the daily discharge limit was restored the next day.

All other wastewater monitoring results indicated compliance with permit-specified effluent limits in 2016.

8.6 Landfill Settlement

Settlement Monitoring at CHRLF began in 1992, and by 2005 seven (7) monitoring locations had been established. More stations were added in 2007, while others were abandoned as a result of operational impacts. The total number of stations is currently nine (9). Annual Settlement, which is in part dependent on refuse thickness as well as time, has varied from 0.18% to 3.79% of refuse thickness. Settlement at all stations monitored in 2016 was negligible. The highest rate was 0.3% of the underlying refuse thickness. It is anticipated that landfill settlement will continue, with older landfill areas settling at a comparatively lower rate.

SECTION 9 - ATTACHMENTS

Attachment A – Permit Renewal Application

Attachment B – Tonnage Report

Attachment C – Disposal Fees

Attachment D – Landfill Capacity Documentation

Attachment E – Financial Assurance Documentation

Attachment F – Annual Summary of Groundwater Monitoring Results

Attachment G – Landfill Gas Probe Monitoring Results

Attachment H – Stormwater Reports